



Project Fact Sheet

Albany HTS Power Cable

This project involved the development and demonstration of a high-temperature superconducting (HTS) cable in the power grid in Albany, New York, including first-of-a-kind applications of a cable splice and a section of cable fabricated using second-generation (2G) superconducting wire.

WHAT ARE ITS PRIMARY APPLICATIONS?

HTS power cables are used for power transmission and distribution. The Albany cable was a distribution cable, and conducted electricity within a local grid.

WHAT ARE THE BENEFITS TO UTILITIES?

HTS is an advanced technology that can both strengthen and improve the electrical system. Superconducting cables offer higher capacity and greater efficiency than conventional cables in the delivery of electric power. HTS AC cables can carry three to five times more power than conventional cables and can meet increasing power demands in urban areas via retrofit applications, eliminating the need to acquire new rights-of-way and to dig new cable pathways. Because electrical resistance is minimal, power can be delivered at lower voltages, eliminating the need for some transformers along the delivery path. In addition, HTS cables are cooled with liquid nitrogen—a material compatible with the atmosphere—in contrast to the hazardous, flammable, and potentially polluting oil used to cool some conventional cables.

WHAT IS THE MARKET POTENTIAL?

The growing economy depends on the reliable and efficient delivery of electricity. As energy demands and environmental concerns increase, underground HTS cable will provide the necessary alternative to meet power supply needs. Power transmission via underground HTS cables can substitute for overhead power lines when environmental and other concerns prohibit overhead installation. The development of



Albany HTS Cable Project — cable termination

a commercially viable HTS power cable will enable U.S. industry to capture a large portion of the growing national power cable market. In addition, international markets are estimated to be 10 times larger than the U.S. market, and those markets are growing more rapidly than the U.S. market.

The second phase of this project resulted in the world's first in-grid demonstration of a power cable that uses 2G ("coated conductor") superconducting wire. The new wires have both performance and cost advantages over earlier HTS wires and are expected to hasten HTS technology's entry into the cable market.

WHAT ARE THE PROJECT ACCOMPLISHMENTS?

The project team chose to use "three-core HTS cable technology," meaning that the cable had three separate copper cores in a single cryogenic pipe (called a *cryostat*). Each core was surrounded by layers of HTS wire and electrical insulation, and the whole assembly was then surrounded by liquid nitrogen coolant and thermal insulation. The design also used a "cold dielectric" scheme, in which the cryogenic fluid and thermal insulation surrounded the electrical insulation in the cable. The cable was designed to carry 800 amps at 34.5 kilovolts.

WHAT IS THE STATUS OF THE PROJECT?

The first phase of the project was energized on July 20, 2006. It operated flawlessly as an integral part of National Grid's 35-kilovolt network in Albany, serving the equivalent of 25,000 homes. It was taken off-line after nine months to begin phase II of the project: replacing a 30-meter section with 2G cable. Phase II of the project was energized on January 8, 2008, and was taken off-line after approximately 2,400 hours of successful operation. This was the world's first installation of a device using 2G wire in a utility grid.

Goal:

To demonstrate the technical and commercial viability of high-temperature superconducting (HTS) cables by operating a 350-meter superconducting cable, including a 30-meter section made from 2G HTS wire, between two National Grid substations.

Team:

SuperPower (Project Lead and 2G HTS Wire)

Linde (Cryogenic System)

Sumitomo Electric (Cable Production)

New York State Energy Research and Development Authority (Additional Funding)

National Grid (Host Utility)

Period of Performance:

7/2003 – 3/2008

Cumulative Project Funding:

Private: \$13.7 Million (50%)

DOE: \$13.7 Million (50%)

Total: \$27.4 Million

Information Contact:

Chuck Weber, SuperPower
(518) 346-1414

cweber@superpower-inc.com



Linde's Cryogenic Refrigeration System (CRS)

The 350-meter cable was installed underground in Albany, New York, between two National Grid substations near the Hudson River and under Interstate 90. The project demonstrated the first-ever splice in an HTS cable. In the second phase of the project, a 30-meter section was replaced with a section of cable made with 2G HTS wire manufactured by SuperPower. In parallel, a manufacturer of cryogenic systems (Linde) developed a refrigeration system that met the stringent reliability and efficiency standards required by the utility industry.

The project was awarded in July 2003. The detailed design was completed and reviewed by DOE in November 2004. The team completed manufacturing of all components of the cable cryogenic system in 2005, and the installation of components was completed by the spring of 2006. The HTS cable was connected to the National Grid network and began operating as part of the grid on July 20, 2006. It was taken off-line after nine

ALIGNMENT WITH ADMINISTRATION PRIORITIES:

National Energy Policy:

"...expand the Department's research and development on transmission reliability and superconductivity."

National Transmission Grid Study:

"... accelerate development and demonstration of its technologies, including high-temperature superconductivity..."

Energy Information Agency:

"Of [advanced power delivery] technologies, superconductivity holds the most promise for yielding significant efficiency gains."

months to begin phase II of the project: replacing a 30-meter section with 2G cable, which was the world's first use of 2G in any utility device. The Albany cable was successfully re-energized on January 8, 2008 and was taken off-line after approximately 2,400 hours of successful operation.

How Does it Work?

Conventional conductors of copper or aluminum are replaced by HTS wire, enabling the cable to carry greater amounts of current with fewer losses due to resistance. The cable requires a cooling system to refrigerate the HTS conductors to a temperature at which resistance is minimized, about -321°F . In the cooling system, liquid nitrogen is circulated within a thermal envelope (cryostat) to cool the superconducting tapes (wires) through which electricity flows. The superconducting tapes, which are wrapped around the core of the cable, make up the phase conductor, replacing the copper or aluminum in conventional cables.

To date, HTS cable demonstration projects have relied on first-generation superconductors, which consist of a powder-like bismuth-based superconductor packed into silver tubes and extruded to form wires. Silver has been the only metal found to have the electrical, chemical, and structural properties required to create high-quality HTS wire. However, its high cost has kept HTS cables from being an economical solution for relieving electrical bottlenecks.

This project incorporated a new kind of wire in which a Yttrium-based superconductor is chemically coated on a non-silver metal substrate. This process has already been scaled up to approximately one kilometer piece lengths employing high-throughput fabrication methods that have been scaled up to manufacturing in the pilot plant at SuperPower.